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Memorandum

To: *Chris Lichens - USEPA*

From: *Dave Chamberlin - CDM*
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Date: *February 5, 2007*

Subject: *Technical Memorandum*
Soil Vapor Extraction Pilot Test Initial Findings
Omega Chemical Superfund Site
10500-37240-T2.OSS.SVEOP
10500-5.2.3

1.0 Introduction

Camp Dresser & McKee Inc. (CDM) has prepared this Technical Memorandum (TM) on behalf of the Omega Chemical Site Potentially Responsible Party (PRP) Organized Group (OPOG) to present the findings of soil vapor extraction (SVE) pilot testing at the Omega Chemical Superfund Site (Site). This document has been prepared in accordance with the Statement of Work (SOW) in Consent Decree (CD) No. 00-12471 between the United States Environmental Protection Agency (EPA) and OPOG, which required OPOG to implement a vadose zone remedial investigation/feasibility study (RI/FS) for contaminant releases on, at, or emanating from the Site. The CD was lodged on November 24, 2000 and entered into the US District Court on February 28, 2001.

The Site consists of the former Omega Chemical Corporation property encompassing approximately one acre located at 12504 and 12512 East Whittier Blvd. and the Phase 1a Area. As defined in the CD and illustrated on Figure 1-1, the Phase 1a Area is the area of soil and groundwater contamination associated with the Omega property and extending downgradient approximately 100 feet southwest of Putnam Street.

The pilot test was conducted to collect data to confirm the feasibility of SVE and to assist in the design and implementation of a potential full-scale SVE system at the Site, if appropriate. The primary volatile organic compounds (VOCs) at the Site and adjacent parcels are tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), Freon 113, and Freon 11.

The pilot test was performed according to the methods described in Soil Vapor Extraction Pilot Test Work Plan (CDM, August 4, 2006) and consisted of two types of tests: step testing and a multi-week pilot test. The step testing was performed to evaluate the relationship between applied vacuum at the SVE wells and 1) the resulting vapor flows; and 2) the resulting vacuum distributions in the subsurface around the wells. The multi-week test provided design information for potential implementation of the SVE technology once near-equilibrium conditions had been established by operating the SVE system for several weeks. In addition, extended operation provided data concerning the mass of contaminants in the vicinity of the test wells.

2.0 Objectives

The overall objectives of the SVE pilot test were to collect additional data which will be used in the selection, design, and implementation of the overall on-site soils remedy for the Site. Specifically, the collected data will aid in selecting the most appropriate SVE design parameters for a potential full-scale system at the Site.

It should be noted that, during the recently completed remedial investigation, an important lithologic layer starting at an approximate depth of 30 feet bgs (hereinafter referred to as the 30 foot clay unit) was noted in borings advanced at the Site and in the vicinity. The 30 foot clay unit is between 3.5 to 11 feet thick, and the top of the unit slopes to the west and southwest (additional discussion is provided in Section 2.4.4 of the RI report). In addition, as discussed in Section 5 of the RI report, the unit appears to be an important factor in contaminant fate and transport at the Site.

Specific objectives for this pilot test included:

- Confirm the feasibility of SVE for site conditions above the 30 foot clay unit identified during implementation of the recently completed remedial investigation.

- Confirm the ability of vapor phase granular activated carbon (GAC) to treat extracted vapors to appropriate discharge limits.

- Estimate the contaminant mass removal rate in extracted vapors to size and select the treatment systems for a potential full-scale system and to evaluate air discharge permit issues.

- Estimate the achievable SVE treatment zone sizes for the interval above the 30 foot clay unit to serve as a basis to select well spacing and construction.
- Provide VOC mass removal data from SVE wells screened in two intervals to help in determining the VOC vertical distribution in the vadose zone above the 30 foot clay unit.

Deviations from Work Plan

The following items were changes from the methods described in the test work plan:

- The work plan called for testing of condensation-based vapor treatment; however, the GAC performed very well and there are concerns regarding the availability of this technology at the scale that would be needed for a full-scale system. Specifically, the manufacturer of this technology currently provides only 100 cubic feet per minute (cfm) units that can be run in series. Such an arrangement for a full-scale system that would need to treat thousands of cfm would be impractical. Therefore, this technology was not tested.
- The work plan called for collection of transient vacuum readings during a minimum of two of the step tests to allow for calculation of intrinsic permeability of the soils. These readings were inadvertently not collected; however, the vacuum distribution data that were collected provided a more technically sound basis on which to design the well spacing for a full-scale system. For completeness, the transient data will be collected as part of the proposed extended testing, if approved.

3.0 SVE Well Installation

Between September 7 and 11, 2006, 10 SVE/monitoring wells were installed on the Site for pilot testing purposes. SVE well locations are shown in Figure 3-1. The SVE wells were installed using 10-inch diameter hollow stem augers and constructed of 4-inch diameter Schedule 40 PVC. Each borehole was continuously sampled using a split spoon sampler to document the soil profile at each location. Five shallow-depth SVE wells (VE-1S to VE-5S) were screened from 12 to 22 feet with 20-slot (0.020-inch opening) perforated PVC casing. The total depth of the shallow-depth SVE wells was approximately 23 feet bgs. Five medium-depth SVE wells (VE-1M to VE-5M) targeted the thin sand layer that exists above the 30-foot clay unit. The total depth of these SVE/monitoring wells was approximately 36 feet, with a screened interval over the lower 10 feet which also used 20-slot perforated PVC casing. # 3 Monterey sand was used for filter pack around the well screens. Hydrated medium-sized bentonite chips (approximately 3 feet thick) were placed in the annulus above the filter pack. The rest of the annulus was backfilled with Portland cement (with 5% bentonite added) grout to the ground surface. Surfaces at each location were completed with a flush-grade, watertight, traffic-rated surface completions. Table 3-1 summarizes the SVE well construction details.

The lithology encountered during well installation was continuously logged from the surface to the final depth according to the Unified Soil Classification System. The boring logs are presented in Appendix A. Field activities were performed in accordance with CDM's Standard Field Procedures Manual and CDM Health and Safety Plan (HASP) for the Omega site. A CDM geologist was present during all of these Site activities.

During drilling and completion of the soil borings, headspace measurements using a MiniRAE photoionization detector (PID) were performed on soil samples at approximate 5-foot intervals. Recorded measurements ranged from 0.0 to 47 parts per million by volume (ppmv). In general, PID soil head space readings recorded during the drilling were above background levels.

4.0 Equipment Setup

This section summarizes the equipment used during the SVE pilot testing.

SVE System Equipment

Northstar Environmental Remediation (NER) was subcontracted to furnish, set up, and maintain a mobile SVE system. The SVE system used consisted of one 25 horsepower (HP) oil-sealed liquid ring pump (Dekker VMAX450) capable of extracting up to 200 actual cubic feet per minute (acfm) at a vacuum of 29 inches of mercury (in. Hg). The skid mounted system was also equipped with an air/water separator with a high water level shutoff switch and drain pump, a particulate filter, 240-volt, 3-phase, 60-amp control panel, vacuum and flow gages and other instrumentation as necessary to operate the system. All system piping, hoses, and conduits were installed above ground.

Vapor Treatment

Soil vapors were treated using two 1,000-pound GAC vessels installed in series to comply with requirements of a South Coast Air Quality Management District (SCAQMD) various-locations vapor treatment permit (Permit No. F78354). Sampling ports were installed at the wellhead and at various locations in the system to monitor and collect system influent and effluent vapor samples. The air discharge from the carbon vessels (effluent), as required by the SCAQMD permit, along with system influent and between the lead and lag GAC vessels were tested using a PID unit calibrated with hexane.

Other Equipment Used during Testing

The following additional equipment was used during testing:

- Subsurface pressure at vapor probes and non-operating wells were measured using magnehelic gauges or a digital pressure meter (OMEGA HHP-103).

- Concentrations of VOCs in the influent, effluent, and outlet (between the GAC units) streams were monitored with a MiniRAE 2000 PID unit, (11.7 eV ionization potential) and a PE Photovac Intrinsically Safe Handheld Flame Ionization Detector (FID) unit. The instruments were calibrated to 100 ppmv isobutelyene and hexane, respectively. 1-liter designated Tedlar bags were used to collect soil gas samples for field analysis.

- A WS-7394U Wireless 433 Mhz Weather Station was used to monitor barometric pressure changes.

- 2-inch diameter (25 to 125 acfm flow range) and 3-inch diameter (50 to 250 acfm flow range) direct read, in-line flow meters (AMETEK ROTRON) were used to measure flow rates at the wellhead and entering the primary GAC vessel. Some flow rate inconsistencies were noted due to the need to alternate between meters for different steps (due to the range differences).

Field equipments were calibrated in accordance with the manufacture's instructions. Instruments requiring field calibration were checked and adjusted before and after each day of use.

5.0 Pilot Test Procedures and Field Measurements

Between October 17 and November 9, 2006, CDM conducted 15 one-day step tests (10 single-well and five combination-well tests) at the 10 SVE well locations. The SVE system is located in the portion of the Site formerly occupied by 3 Kings Construction. Appendix B contains a detailed discussion of pilot test procedures and results. The field data collected during the pilot test are summarized in Tables 5-1 through 5-3. Graphs illustrating vacuum measurements collected at each well versus the applied vacuum at each step are also provided in Appendix B, Figures B-1 through B-10.

6.0 Analytical Sampling

Soil vapor samples were collected from the system influent, between the GAC canisters (outlet) and system discharge point (effluent) and analyzed for VOCs in accordance with EPA Method No. TO-15. Soil vapor samples were submitted to SunStar Laboratories, Inc (SunStar), a State-certified environmental laboratory located in Tustin, California. The air samples were collected by using 1000 cubic centimeter (cc) silonite-coated steel canisters provided by SunStar. Table 6-1 summarizes the soil vapor analytical results. The laboratory analytical reports are provided as electronic pdf files on the compact disc in Appendix C.

7.0 Evaluation of Pilot Test Results

This section presents an interpretation of the test results with regard to the test objectives.

Radius of Influence

Typical pressure distributions (both plan view and in cross section) that were measured during testing are included in Appendix D, Figures D-1 through D-9. The achievable radius of influence (ROI) during the testing was typically greater than 75 feet. This uses a ROI that is defined by at least 0.1 in. H_2O vacuum. Such an ROI was typically achievable by applying approximately 10 in. Hg to the both shallow and medium wells. The corresponding vapor extraction rate ranged between 50 and 70 standard cubic feet per minute (scfm) for the shallow wells and 68 and 103 scfm for the medium wells (Figure D-2).

The vacuum distribution data indicate that vacuum was induced in the medium soil depths during operation of the shallow wells and vice versa. This indicates that the soils are sufficiently and uniformly permeable to allow the entire 30-foot interval of the vadose zone above the 30 foot clay unit to be remediated by SVE wells screened over one long interval (as opposed to the two screen intervals used for the test).

VOC Mass Removal Rates

The analytical results indicated that the VOCs most commonly detected in the soil vapor samples were PCE, TCE, 1,1- DCE, Freon 11, and Freon 113. Distributions of the VOC concentrations are illustrated for both shallow and medium SVE wells and are included in Appendix E (Figures E-1 through E-3).

These data can be used to determine breakthrough times for each VOC which can in turn be used as a basis to design full-scale GAC treatment units and estimate breakthrough times for such a system, as appropriate.

The VOC mass removal rate for the system was estimated by multiplying the linearly interpolated daily extraction flow rate by the linearly interpolated VOC concentrations of the soil gas samples. Analytical results of the system influent were used to calculate VOC mass removal rates (Figure 7-1). The estimated VOC mass removal rates and cumulative mass removal are presented in the operations summary (Table 7-1) and illustrated in Figures 7-2 and 7-3.

Between October 17, and November 22, 2006, approximately 415 pounds of VOCs were estimated to have been removed from the Site. In general, VOC mass removal rates of approximately 35 pounds per day (lbs/day) were achievable from each well, although the rates increased at those wells that were closer to the Star City Auto Body building.

Vapor Treatment

The soil vapor analytical data collected at the system influent, in-between carbon units, and at the effluent port of the GAC units indicated that the GAC was capable of removing all VOCs in the extracted vapors (Table 6-1). Based upon the recorded flow rates, it is estimated that approximately 7.2 million cubic feet of soil vapor were extracted and treated during this pilot test.

8.0 Conclusions

The following are the main conclusions of the pilot test performed as of the writing of this TM:

- SVE is a feasible technology for the vadose zone above the 30 foot clay unit.
- A ROI of at least 75 feet could be achieved at the shallow wells at an applied vacuum of approximately 10 inches of Hg. This resulted in a vapor extraction flow of approximately 50 to 70 scfm.
- A ROI of at least 75 feet could be achieved at the medium wells at an applied vacuum of approximately 10 inches of Hg. This resulted in a vapor extraction flow of approximately 68 to 103 scfm.
- VOC mass removal rates ranged from 2 to 84 pounds per day, depending on the SVE well operated. A total of 415 lbs of VOCs were removed during this pilot test. The results indicated that there is generally more VOC mass in the medium depth soils compared to the shallow depth soils.
- The GAC treatment units were capable of removing the VOCs found in the extracted soil vapors. The analyses of the samples that were collected at the GAC units provided a basis to evaluate and design GAC treatment for a potential full-scale SVE system, if appropriate.
- The vacuum distributions measured during testing indicated that single depth wells could be used to remediate soils above the 30 foot clay unit (as opposed to the dual depth wells that were used in this testing).

9.0 Recommendations for Proposed Additional Testing

In order to collect data that may be critical to evaluation and comparison of different SVE alternatives in the Feasibility Study, it is proposed that the SVE pilot testing be expanded to gather more data concerning the heterogeneity of the vadose zone in the source area and the peak and constancy of the VOC concentrations that may be encountered with a full-scale system. The site conceptual model indicates that the area of highest VOC concentrations in the upper vadose zone is likely to be between Star City Auto Body and the Medlin building located in the northwestern quadrant of the Site. The pilot test should be expanded by installing four new wells in this area that should be screened from 10 to 30 feet bgs. The benefits of this expansion would be to 1) verify the conclusion that two screened intervals are not required for the soils above the 30-foot clay unit, 2) determine the heterogeneity of the soils throughout the site, 3) determine the peak VOC concentration, and (4) determine the impact of removal on the total VOC mass in the vadose zone. As before, these wells would be able to be used as SVE wells or as monitoring wells to collect vacuum readings. Two of these proposed wells would be located to the north of Star City, one behind the loading dock at the back of Star City, and one further to the west on the Terra Pave property, as shown on Figure 9-1.

Information gained from operating these additional wells will be used to assess the cost effectiveness of using GAC for vapor treatment for a full-scale system. While the existing test data confirmed that GAC is feasible for vapor treatment at the Site, uncertainty about the mass of VOCs in the targeted soils precludes identifying which vapor treatment technology is most cost effective. For example, if the VOC mass in the proposed test expansion area is very high, then a technology such as the condensation based treatment would likely be more cost effective than GAC. To address this uncertainty, it is proposed to operate the new wells for a minimum of 2 months to determine how quickly the VOC concentrations in the extracted vapors decrease, as this will be relative to the mass of VOCs present within the ROI of the wells. In addition, the proposed well spacing will confirm the earlier results that indicate a design ROI of 75 feet is achievable throughout the Site, and provide important information on the efficacy of SVE in other areas of the Site.

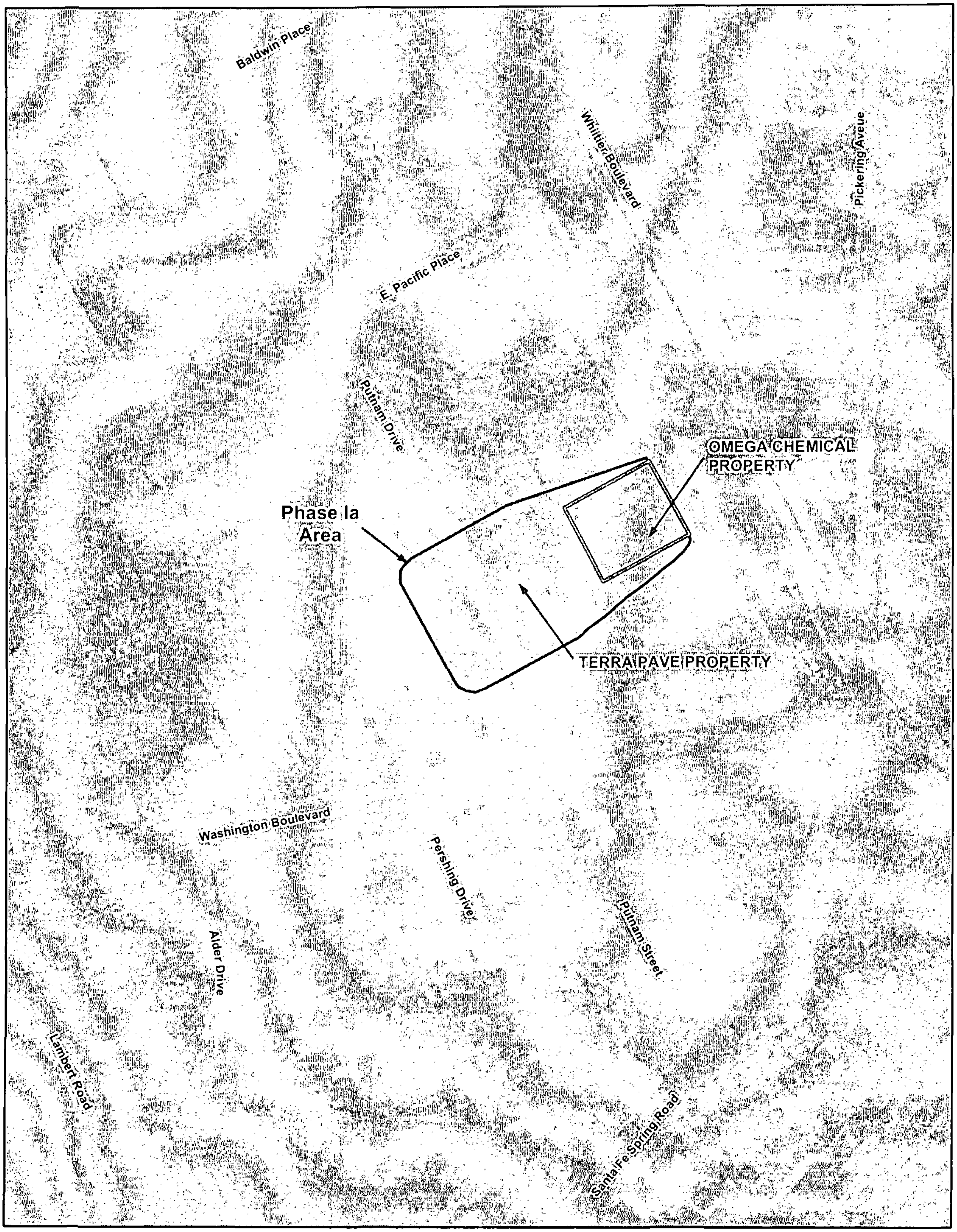
The data collected during the pilot test demonstrate that the SVE system is highly effective in removing VOC contaminant mass from the subsurface, and thereby reducing in-situ soil vapor concentrations. Because migration of these shallow soil vapors to indoor air represent the only potentially completed exposure pathway at the Site, continued reductions in mass and vapor concentrations can only have a beneficial impact to the site. In light of this significant beneficial value, and in the absence of any disadvantage to continued operation, it is strongly recommended that the pilot-scale SVE system continue to operate until it is no longer beneficial or a full-scale remedy can be put in place.

References

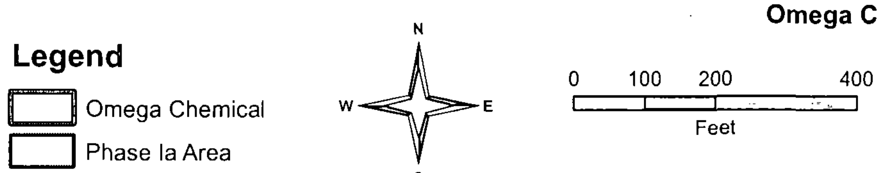
CDM, 2006. *Soil Vapor Extraction Pilot Test Work Plan,* August 4.

CDM, 2007. *Draft Human Health Risk Assessment for On-Site Soils*, January 19.

CDM, 2007. *Draft On-Site Soils Remedial Investigation Report*, January 19.



Omega Chemical Superfund Site



Site Location Map

Figure 1-1

Legend

- Property Boundary
- Road Center
- Omega Chemical Superfund Site
- Building
- Soil Vapor Extraction Well

0 15 30 60
Feet

CDM

Omega Chemical Super Fund Site

Pilot Test Soil Vapor Extraction Well Location

Figure 3-1

Figure 7-1
Omega Chemical Superfund Site
Pilot SVE System Analytical Influent Results

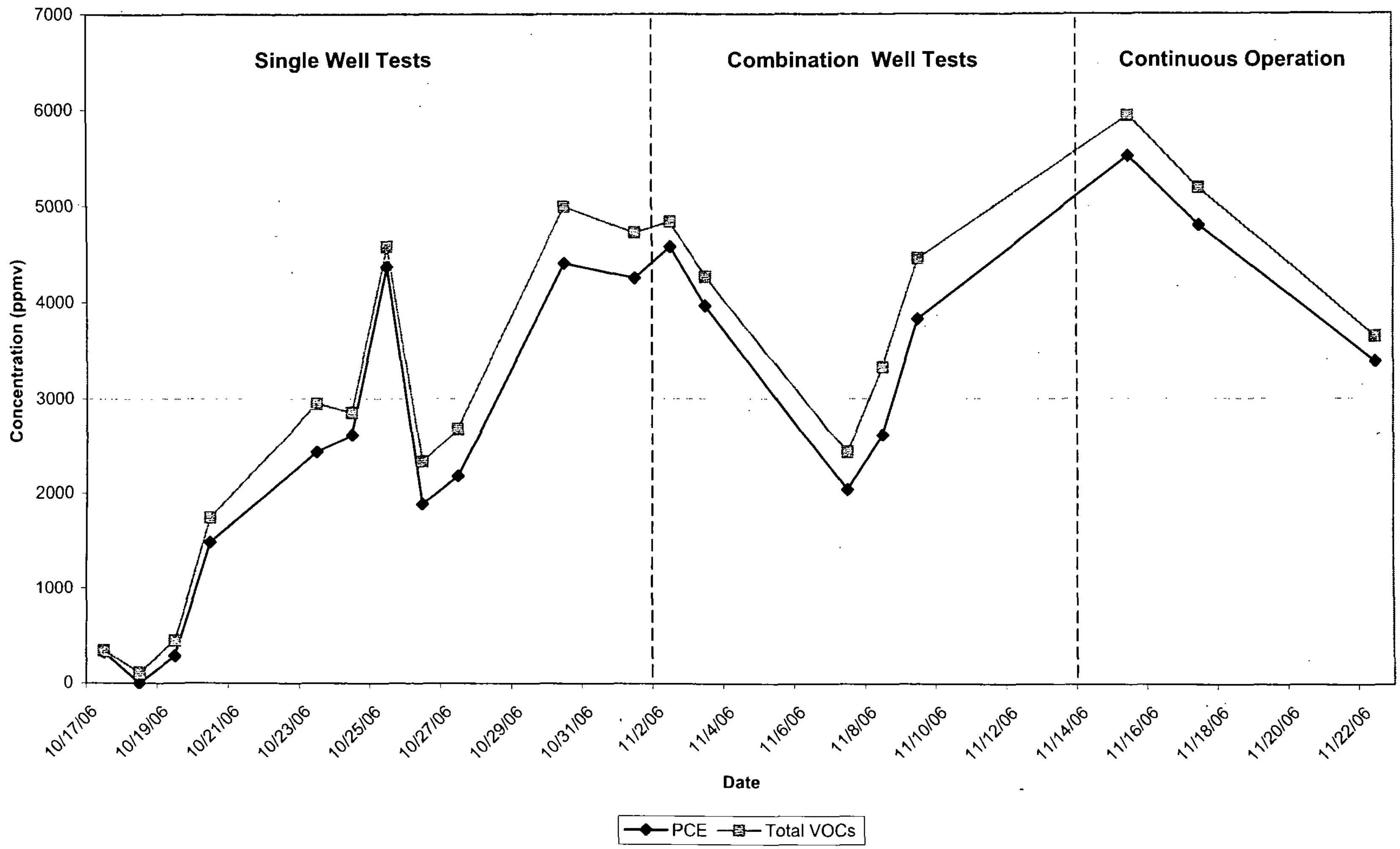


Figure 7-2
Omega Chemical Superfund Site - SVE Pilot Test
Estimated VOC Mass Removal Rates

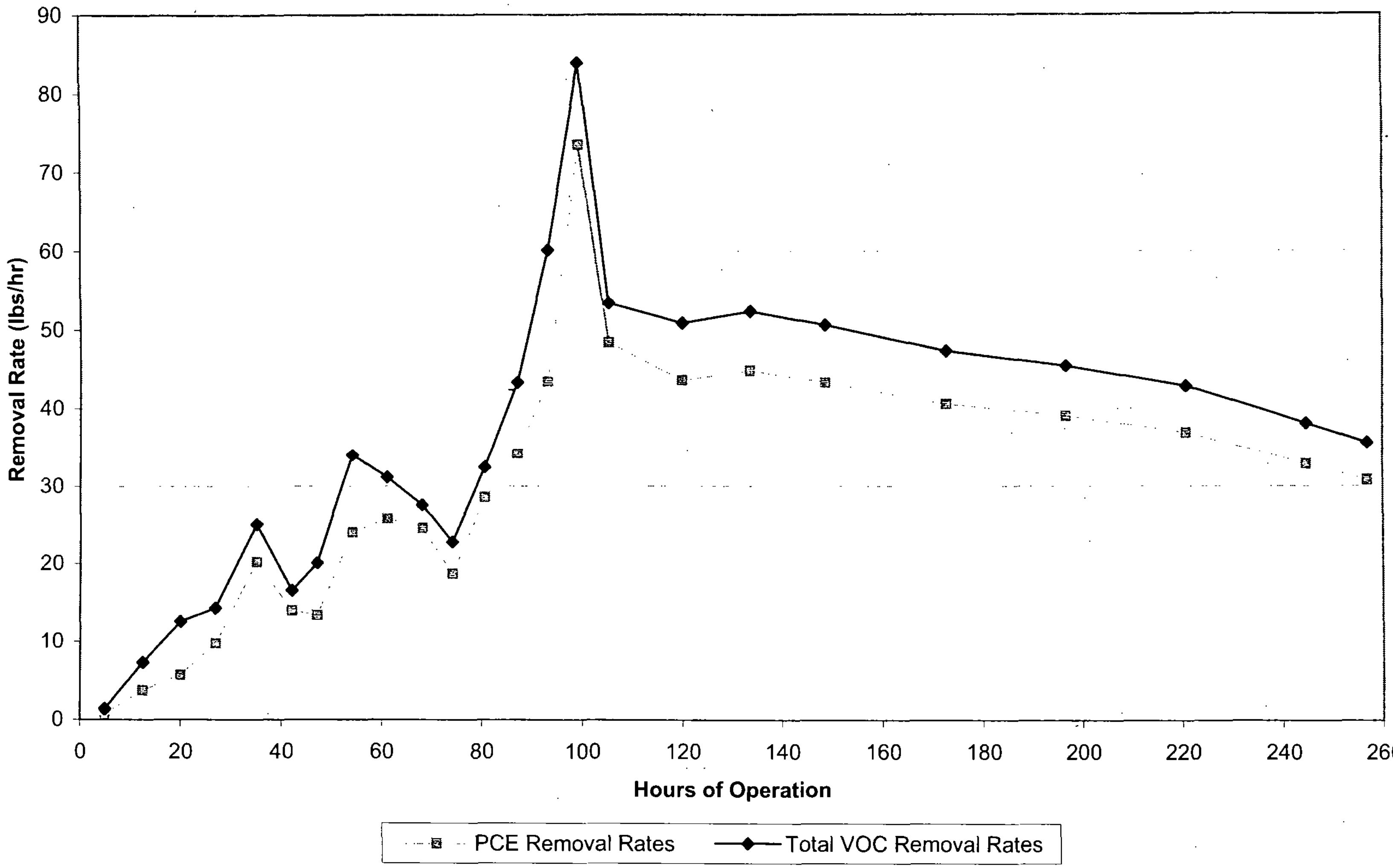


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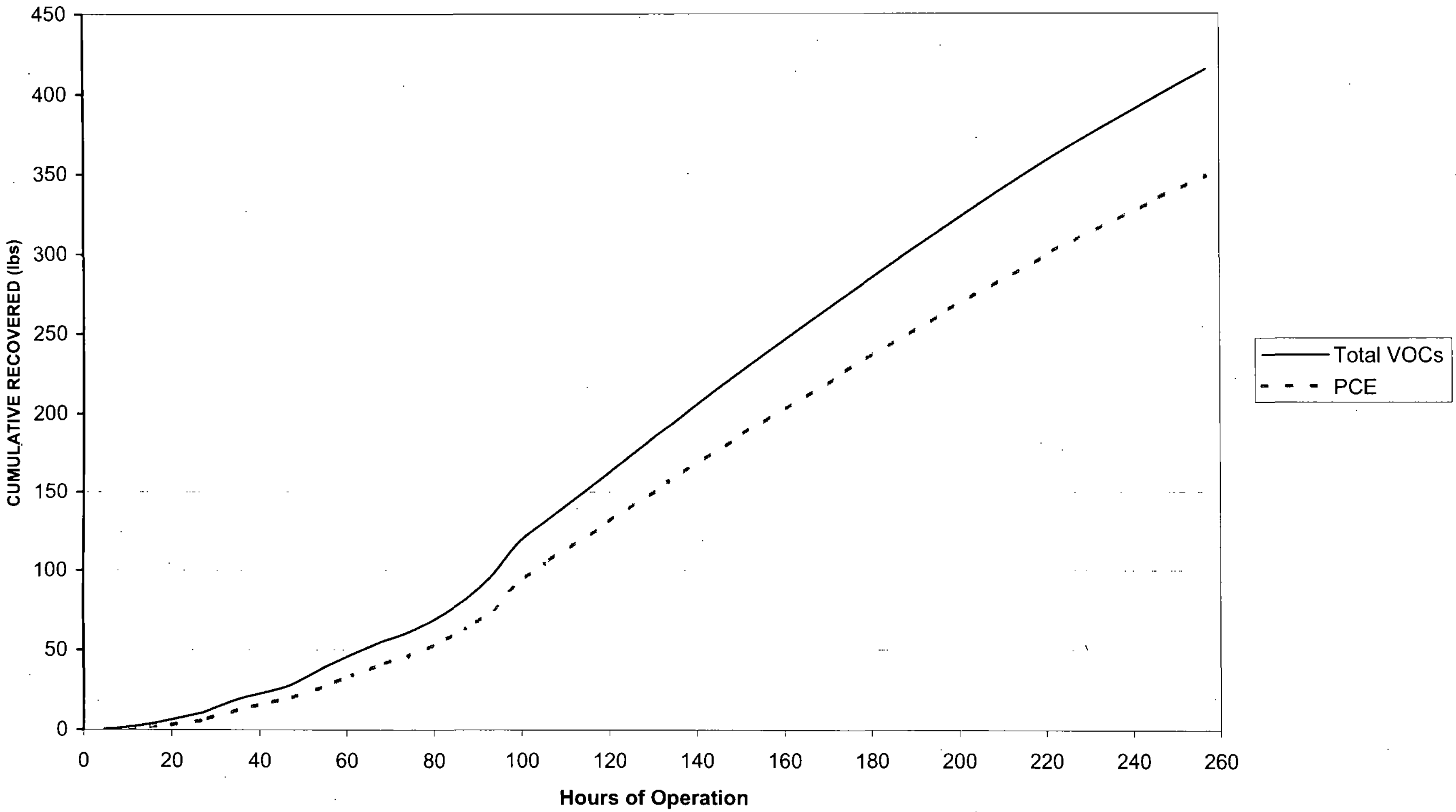
Figure 7-3
Omega Chemical Superfund Site - SVE Pilot Test
Cumulative Mass Removal



Legend

- Omega Chemical Superfund Site
- Building
- Property Boundary
- Soil Vapor Extraction Well
- Proposed SVE Well Locations

0 12.5 25 50
Feet

CDM

Omega Chemical Super Fund Site
Location of Proposed Additional SVE Wells
Figure 9-1

Table 3-1
SVE Well Construction Details
Omega Chemical Superfund Site

Well ID	Total Drilled Depth (feet)	Screened Interval (feet bgs)	Filter Pack Interval (feet bgs)	Bentonite Seal Interval (feet bgs)	Date Drilled
VE-1S	23	12.5 - 22.5	10 - 23	7 - 10	9/7/2006
VE-1M	36.5	26 - 36	24 - 36.5	21 - 24	9/8/2006
VE-2S	23	12 - 22	10 - 23	7 - 10	9/8/2006
VE-2M	36.5	26 - 36	23.8 - 36.5	21 - 23.8	9/11/2006
VE-3S	23	12.5 - 22.5	9.8 - 23	6.8 - 9.8	9/7/2006
VE-3M	36.5	26 - 36	24 - 36.5	21 - 24	9/7/2006
VE-4S	22.5	12 - 22	9.5 - 22.5	7 - 9.5	9/8/2006
VE-4M	36.5	26 - 36	24 - 36.5	21 - 24	9/8/2006
VE-5S	23	12 - 22	9.9 - 23	7 - 9.9	9/11/2006
VE-5M	36.5	26 - 36	24 - 36.5	21 - 24	9/11/2006

Note:
bgs: below ground surface

Table 5-1
Omega Chemical Superfund Site SVE Pilot Test
Single Well Tests Summary

Active Wellhead		Wellhead Vacuum (in. Hg)	Flow Rate (ACFM)	Flow Rate (SCFM)	Liquid Ring Pump Vacuum (in. Hg)	Start Time	End Time	Step Duration (min.)	Influent PID (ppmv)	Influent FID (ppmv)
VE-1S	Step 1*	10	96	63	25	8:10	9:00	50	76	68.8
	Step 2	15	100	47	26	11:01	13:50	169	0.9	70.6
	Step 3	17	125	52	22	13:50	16:15	145	5.3	71
VE-2S	Step 1	10	85	55	26	8:42	11:04	142	78	363.4
	Step 2	13	120	65	25	11:04	13:42	158	85	386.7
	Step 3*	16	120	55	22	13:42	16:16	154	76	393
VE-3S	Step 1	10	80	50	26	8:38	11:16	158	159	590
	Step 2	13	120	64	24	11:16	13:32	136	160	603
	Step 3*	16	128	58	22	13:32	16:05	153	160	581
VE-4S	Step 1	10	84	54	26	8:20	10:35	135	135	851
	Step 2*	14	105	54	24	10:35	13:05	150	142	741
	Step 3*	15.5	130	61	22	13:05	15:25	140	136	679
VE-5S	Step 1*	8	80	57	26	8:10	10:43	153	289	717
	Step 2*	10	108	70	23	11:52	14:08	136	341	871
	Step 3*	13	117	64	20	14:08	16:23	135	325	988
VE-1M	Step 1	10	105	68	23	8:20	10:31	131	119	228
	Step 2	12	150	87	21	10:31	13:02	151	155	376
	Step 3	13	170	93	19.5	13:02	15:30	148	189	434
VE-2M	Step 1	9	140	97	21	8:40	11:00	140	165	446
	Step 2	10	160	103	20	11:00	13:25	145	221	544
VE-3M	Step 1	6	83	64	24	7:45	10:00	135	403	714
	Step 2	10	120	76	20.5	10:00	12:15	135	352	814
	Step 3	12	150	86	18	12:15	14:26	131	341	797
VE-4M	Step 1	6	85	65	21	8:05	10:33	148	280	531
	Step 2	10	110	70	17	10:33	12:50	137	318	675
	Step 3	12	145	82	18	12:50	15:00	130	390	979
VE-5M	Step 1	6	75	59	26	7:45	9:52	127	378	545
	Step 2	9	120	81	18	9:52	12:10	138	487	896
	Step 3	10	105	68	17	12:10	14:26	136	506	955

Notes

in Hg	inches of mercury
ACFM	actual cubic feet per minute
SCFM	standard cubic feet per minute
in. H2O	inches of water
ppmv	parts per million by volume
*	Data collected during Single Well Data Gap Step Tests

Table 5-2
Omega Chemical Superfund Site SVE Pilot Test
Combination Well Tests Summary

Well ID	Wellhead Vacuum (in. Hg)	Flow Rate (ACFM)	Flow Rate (SCFM)	Liquid Ring Pump Vacuum (in. Hg)	Start Time	End time	Trial Duration (min.)	Influent PID (ppmv)	Influent FID (ppmv)
VE-1S	9.2	123	82	17.9	8:30	14:55	385	291	298
VE-1M	4.8	119	96						
VE-2S	9.4	122	81	17.9	8:30	14:55	385	389	470
VE-2M	2.5	118	104						
VE-3S	8.1	124	85	16.9	8:50	14:55	365	423	650
VE-3M	6.1	121	91						
VE-4S	8.9	123	82	17.5	8:35	14:40	365	673	1150
VE-4M	6.2	118	89						
VE-5S	6.1	80	61	16.9	8:40	14:55	375	848	821
VE-5M	4	76	63						

Notes

in. Hg inches of mercury
ACFM actual cubic feet per minute
SCFM standard cubic feet per minute
ppmv parts per million by volume

Table 5-3
Omega Chemical Superfund Site SVE Pilot Test
Continuous Operation Summary

Week	Date	VE-2S Vacuum (in. Hg)	VE-2S Flow Rate (SCFM)	VE-2M Vacuum (in. Hg)	VE-2M Flow Rate (SCFM)	Influent (ppmv)	Notes
11/14 - 11/19*	11/14/2006						
	11/15/2006	8	91	1.2	82	672	EPA site visit; system shut down due to breakthrough
	11/17/2006	7.9	85	3.5	96	612	Primary carbon vessel exchanged; system restart
11/20 - 11/24	11/20/2006	7 1	98	3.2	99	560	
	11/21/2006	--	--	--	--	550	
	11/22/2006	7	96	3	96	502	System shut down due to breakthrough/holidays
11/27 - 12/1	11/29/2006	7.8	93	3.1	101	439	Primary carbon vessel exchanged; system restart
	11/30/2006	--	--	--	--	486.7	
	12/1/2006	--	--	--	--	465	System shut down due to weekend
12/4 - 12/8	12/4/2006	--	--	--	--	509	System restart
	12/5/2006	6.8	97	3	94	392	
	12/7/2006	--	--	--	--	250	System shutdown due to possible breakthrough
12/11 - 12/15	12/11/2006	7 2	98	3.1	98	262.9	System restart
	12/12/2006	--	--	--	--	272	
	12/13/2006	--	--	--	--	250	System shut down due to breakthrough

Notes

in Hg inches of mercury
SCFM standard cubic feet per minute
ppmv parts per million by volume
* Operated through the weekend

Table 6-1
Omega Chemical Superfund Site
Summary of SVE Pilot Test Analytical Data

Well ID	Sample Date	Sample Time	Sample Type	Total VOCs	1,1,1 TCA	1,1,2 Trichloro-1,2,2 trifluoroethane (Freon 113)	1,1 DCA	1,1 DCE	1,2,4 TCB	1,2,4 TMB	1,2 DCA	1,3,5 TMB	2-Butanone	4-Ethyltoluene	Acetone	Benzene	Carbon Tetrachloride	Chloroform	Cis 1,2 DCE	Cyclohexane	Dichlorodifluoromethane (Freon 12)	Ethylbenzene	Heptane	Hexane	m,p-Xylenes	Methylene Chloride	o-Xylene	Styrene	PCE	Tetrahydrofuran	Toluene	Trans 1,2-DCE	TCE	Trichlorofluoromethane (Freon 11)	Vinyl Chloride
Single Well Tests																																			
VE-1S	17-Oct-06	15:35	EFF	79	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	34	1 U	23	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U	18	4.1	1 U	1 U	1 U	1 U	1 U
VE-1S	17-Oct-06	15:37	OUT	170	1 U	12	1 U	8.8	1 U	2.7	1 U	1.7	16	1 U	25	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U	70	8.2	1 U	1 U	1.7	3.8	1 U
VE-1S	17-Oct-06	15:43	IN	43,790	170	8700	250	7300	4.3	33	27	6.5	32	1 U	18	7.4	1 U	220	330	8.5	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U	22000	76	1 U	47	660	3500	1 U
VE-2S	18-Oct-06	15:47	EFF	425	1 U	52	1 U	55	1 U	7.8	1 U	3.7	46	7.1	50	1 U	1 U	1 U	5.4	1 U	1 U	1.5	1 U	1 U	7	1 U	4	1 U	150	4.7	2.1	1 U	8.7	24	1 U
VE-2S	18-Oct-06	15:50	OUT	471	1 U	58	1 U	66	1 U	1 U	1 U	1 U	31	1 U	30	1 U	1 U	1 U	8.1	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U	270	4.3	1 U	1 U	14	29	1 U
VE-2S	18-Oct-06	15:54	IN	237,894	150	42000	900	51000	1 U	1 U	1 U	1 U	5 U	1 U	5 U	12	2.1	620	4900	8.2	11	1 U	1 U	1 U	2 U	1 U	1 U	1 U	110000	54	2.2	500	6900	21000	6.9
VE-3S	19-Oct-06	15:38	EFF	522	1 U	80	2.1	88	1 U	18	1 U	14	35	6.6	30	1 U	1 U	1 U	8.9	1 U	1 U	1 U	1 U	1 U	11	1 U	14	1 U	180	4.9	1 U	1 U	12	79	1 U
VE-3S	19-Oct-06	15:41	IN	416,339	150	55000	940	140000	1 U	260	1 U	1 U	5 U	1 U	5 U	34	25	400	940	12	14	1 U	1 U	1 U	2 U	1 U	1 U	1 U	160000	32	15	1500	20000	37000	17
VE-4S	20-Oct-06	15:00	EFF	379	1 U	56	1 U	36	1 U	1.3	1 U	1.8	36	3.2	11	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2	1 U	2.4	1 U	170	1 U	1.2	1 U	9.4	27	1 U
VE-4S	20-Oct-06	15:06	IN	411,661	50 U	41000	1900	61000	50 U	81	50 U	50 U	50 U	50 U	50 U	110	50 U	1700	6100	50 U	50 U	50 U	50 U	50 U	50 U	50 U	60	50 U	260000	50 U	50 U	1300	17000	22000	50 U
VE-5S	23-Oct-06	13:48	EFF	456	1 U	1 U	1 U	98	1 U	1 U	1 U	1 U	69	1 U	43	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U	160	1 U	1 U	1 U	14	72	1 U
VE-5S	23-Oct-06	13:51	OUT	178	1 U	3.8	1 U	5.2	1 U	1 U	1 U	1 U	52	1 U	28	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U	39	1 U	1 U	1 U	1 U	1 U	1 U
VE-5S	23-Oct-06	13:52	IN	665,983	2100	45000	1600	73000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	250	50 U	3100	780	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	510000	50 U	63	2100	29000	50 U	50 U
VE-5S	23-Oct-06	16:04	EFF	1,041	1 U	1 U	1 U	100	1 U	4.9	1 U	1.8	43	3.3	26	1 U	1 U	4.5	1 U	1 U	1 U	1 U	1 U	1 U	5.5	1 U	4.4	1 U	810	1 U	1.8	1 U	36	1 U	1 U
VE-5S	23-Oct-06	16:06	IN	472,810	1700	29000	1200	52000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	210	50 U	2400	600	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	390000	50 U	50 U	1600	18000	16000	50 U
VE-1M	24-Oct-06	15:03	EFF	569	1 U	48	1 U	74	1 U	1 U	1 U	1 U	22	1 U	18	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U	340	1 U	1 U	1 U	22	48	1 U
VE-1M	24-Oct-06	15:06	IN	287,700	1700	11000	1400	72000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	1900	1000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	210000	50 U	50 U	50 U	4700	4400	50 U
VE-2M	25-Oct-06	13:00	EFF	3,836	1 U	22	1 U	59	1 U	68	1 U	35	5 U	69	77	400	1 U	1 U	1 U	1 U	1 U	220	190	18	1100	1 U	190	1 U	190	1 U	1200	1 U	1 U	22	1 U
VE-2M	25-Oct-06	13:05	IN	357,940	620	25000	1200	54000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	1300	44000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	210000	50 U	50 U	920	7900	13000	50 U
VE-3M	26-Oct-06	14:07	EFF	253	1.2	27	1.8	52	1 U	140	1 U	89	19	28	11	1.1	1 U	1 U	2.7	1 U	1 U	3.2	4.5	1 U	100	1 U	69	1 U	170	2.5	6.3	1.5	8.4	14	1 U
VE-3M	26-Oct-06	14:08	IN	711,951	340	39000	1200	180000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	770	860	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	450000	50 U	81	2800	28000	29000	50 U
VE-4M	27-Oct-06	14:08	EFF	579	2.9	29	2.9	91	1 U	14	1 U	7	18	3	12	1.2	1 U	7.6	4.1	1 U	1 U	2	1 U	1 U	14	1 U	8.2	1	320	1.8	4.7	2.9	20	70	1 U
VE-4M	27-Oct-06	14:10	IN	690,260	3300	12000	1200	90000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	230	50 U	3100	330	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	490000	50 U	50 U	1300	21000	7900	50 U
VE-4M	27-Oct-06	14:43	EFF	466	1 U	28	2.1	110	1 U	1 U	1 U	1 U	21	1 U	15	1 U	1 U	1 U	1.6	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	1 U	240	2.8	2.2	3.3	18	74	1 U
VE-4M	27-Oct-06	14:45	IN	653,510	1700	25000	1600	75000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	170	50 U	2600	3000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	510000	50 U	50 U	1500	22000	11000	50 U
VE-5M	30-Oct-06	14:08	EFF	579	2.9	29	2.9	91	1 U	14	1 U	7	18	3	12	1.2	1 U	7.6	4.1	1 U	1 U	2	1 U	1 U	14	1 U	8.2	1	320	1.8	4.7	2.9	20	20	1 U
VE-5M	30-Oct-06	14:10	IN	890,260	3300	12000	1200	90000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	230	50 U	3100	330	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	490000	50 U	50 U	1300	21000	7800	50 U
VE-5S	01-Nov-06	14:09	OUT	589	4.8	27	1.9	58	1 U	1 U	1 U	1 U	18	1 U	16	1 U	1 U	1 U	1 U	1 U	18	1 U	1 U	1 U	2 U	1 U	1 U	1 U	370	3	1 U	2	22	14	13
VE-5S	01-Nov-06	14:12	IN	608,860	2100	25000	1200	68000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	220	50 U	2500	540	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	470000	50 U	50 U	2100	27000	15000	50 U
Combination Well Tests																																			
VE-1S/1M	02-Nov-06	14:14	EFF	203	1 U	1 U	1 U	12	1 U	6.4	1 U	7.9	41	4.7	33	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	12	1 U	6.1	1 U	76	1 U	1 U	1 U	1 U	8.5	1 U
VE-1S/1M	02-Nov-06	14:15	OUT	172	1 U	1 U	1 U	7	1 U	6.8	1 U	4.2	31	5.5	23	1 U	1 U	1 U	1 U	1 U	34	1 U	1 U	1 U	7.1	1 U	5	1 U	29	1 U	2.2	1 U	1 U	5	12
VE-1S/1M	02-Nov-06	14:17	IN	311,590	1300	8200	850	96000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	1300	570	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	260000	50 U	50 U	50 U	3100	2300	50 U
VE-2S/2M	03-Nov-06	14:33	EFF	675	1 U	17	1 U	49	1 U	20	1 U	13	44	24	40	14	1 U	1 U	1 U	1 U	1 U	11	31	21	93	1 U	41	1 U	190	1 U	54	1 U	1 U	12	1 U
VE-2S/2M	03-Nov-06	14:34	OUT	206	1 U	1.8	1 U	19	1 U	1.1	1 U	1.5	12	2.1	22	1 U	1 U	1 U	1 U	1 U	16	1 U	1 U	1 U	5.8	1 U	2.4	1 U	38	1 U	2.5	1 U	1 U	28	12
VE-2S/2M	03-Nov-06	14:36	IN	410,700	800	19000	1100	65000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	1200	1700	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	300000	50 U	50 U	1100	8800	11000	50 U
VE-3S/3M	07-Nov-06	14:31	EFF	762	1 U	41	1 U	130	1 U	4.1	1 U	1.8	140	7.6	100	1 U	1 U	1	1 U	1 U	9.7	1 U	1 U	1 U	1.9	1 U	1.9	1 U	280	1 U	1 U	1 U	18	46	1 U
VE-3S/3M	07-Nov-06	14:33	OUT	1,008	1 U	5.7	1 U	300	1 U	3.9	1 U	2	88	2.5	66	1 U	1 U	1 U	1 U	1 U	69	1 U	1 U	1 U	4.3	46	2.4	1 U	79	4.2	1 U	1 U	5.9	290	79
VE-3S/3M	07-Nov-06	14:37	IN	621,170	300	23000	990	140000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	590	450	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	400000	50 U	58	2800	10000	23000	50 U
VE-4S/4M	08-Nov-06	14:09	EFF	1,130	1 U	49	1 U	260	1 U	1 U	1 U	1 U	97	1 U	64	1 U	1 U	1 U	1 U	1 U	20	1 U	1 U	1 U	2 U	1 U	1 U	1 U	540	1 U	1 U	1 U	79	54	7.4
VE-4S/4M	08-Nov-06	14:10	OUT	27,466	50 U	50 U	50 U	22000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	66	50 U	50 U	50 U	50 U	1400	50 U
VE-4S/4M	08-Nov-06	14:12	IN	842,325	3100	14000	1800	80000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	160	50 U	2900	2800	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	700000	50 U	65	2500	25000	10000	50 U
VE-5S/5M	09-Nov-06	14:27	OUT	51,400	50 U	50 U	50 U	41000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	140	50 U	50 U	860	50 U	50 U	50 U	50 U	9400	50 U
VE-5S/5M	09-Nov-06	14:29	IN	719,784	4700	10000	1100	44000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	230	50 U	2800	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	630000	50 U	54	1600	19000	6700	50 U
Continuous Operation																																			
VE-2S/2M	15-Nov-06	13:21	OUT	205,660	50 U	1100	500	170000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	170	490	50 U	50 U	50 U	50 U	50 U	50 U	730	50 U	50 U	170	50 U	50 U	50 U	50 U	33000	50 U
VE-2S/2M	15-Nov-06	13:24	IN	521,780	1400	8900	1200	63000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	2400	790	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	420000	50 U	50 U	1700	14000	7400	50 U
VE-2S/2M	17-Nov-06	11:27	OUT	811	1 U	23	1 U	210	1 U	1 U	1 U	1 U	30	1 U	22	1 U	1 U	1 U	1 U	1 U	18	1 U	1 U	1 U	2 U	1 U	1 U	1 U	220	1 U	1 U	1 U	16	140	14
VE-2S/2M	17-Nov-06	11:29	IN	495,540	1400	9400	1100	49000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	2300	740	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	390000	50 U	50 U	1700	13000	6800	50 U
VE-2S/2M	22-Nov-06	11:49	IN	318,196	1800	5200	530	36000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	63	50 U	1600	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	260000	50 U	53	940	11000	9500	50 U
VE-2S/2M	22-Nov-06	11:51	OUT	106,420	1900	12000	1300	67000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	1100	520	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	3700	50 U	50 U	1800	7200	7800	50 U

Notes:
All units are reported in ppbv
Only VOCs detected in one or more VE samples are listed on table
All samples analyzed using EPA Method TO-15
TCA = Trichloroethane, DCA = Dichloroethane, DCE = Dichloroethene, TCB = Trichlorobenzene, TMB = Trimethylbenzene, PCE = Tetrachloroethene, TCE = Trichloroethene
Sample Type: IN = Influent, EFF = Effluent, OUT = Outlet
U = not detected above the laboratory reporting limit

Table 7-1
OPERATION SUMMARY AND ESTIMATED REMOVAL RATES FOR PILOT SVE SYSTEM
OMEGA CHEMICAL SUPERFUND SITE

Date	System Status	Hours of Operation	Sample COLLECTED	Flow Rate (SCFM)	Flow Rate (SCFD)	Total VOC Conc. (ug/L)	PCE Conc. (ug/L)	Est. VOC Rem. Rate (lbs/day)	Est.PCE Rem. Rate (lbs/day)	Cum. VOC Removed (lbs)	Cum. PCE Removed (lbs)
17-Oct-06	On	5	1	56.86	81,878	280.60	151.98	1.42	0.77	0.3	0.2
18-Oct-06	On	12.5	2	55.00	79,200	1481.03	750.92	7.26	3.73	3	1
19-Oct-06	On	20	3	57.69	83,074	2439.95	1105.33	12.55	5.68	6	3
20-Oct-06	On	27	4	60.92	87,725	2627.01	1796.17	14.27	9.75	11	6
21-Oct-06	Off	27		0.00	0	0.00	0.00	0.00	0.00	11	6
22-Oct-06	Off	27		0.00	0	0.00	0.00	0.00	0.00	11	6
23-Oct-06	On	35.25	5	64.46	92,822	4369.10	3523.25	25.11	20.25	19	13
24-Oct-06	On	42.25	6	98.43	141,739	1881.49	1588.92	16.51	13.94	24	17
25-Oct-06	On	47.25	7	103.36	148,838	2178.01	1450.75	20.07	13.37	28	20
26-Oct-06	On	54.25	8	86.72	124,877	4404.16	3108.75	34.05	24.03	38	27
27-Oct-06	On	61.25	9	82.27	118,469	4252.36	3523.25	31.19	25.84	47	34
28-Oct-06	Off	61.25		0.00	0	0.00	0.00	0.0	0.0	47	34
29-Oct-06	Off	61.25		0.00	0	0.00	0.00	0.0	0.0	47	34
30-Oct-06	On	68.25	10	67.58	97,315	4577.23	4075.92	27.58	24.56	55	41
31-Oct-06	Off	68.25		0.00	0	0.00	0.00	0.0	0.0	55	41
1-Nov-06	On	74.25	11	64.46	92,822	3964.62	3246.92	22.78	18.66	61	46
2-Nov-06	On	80.75	12	178.58	257,155	2039.46	1796.17	32.47	28.59	70	54
3-Nov-06	On	87.25	13	185.06	266,486	2624.60	2072.50	43.30	34.19	82	63
4-Nov-06	Off	87.25		0.00	0	0.00	0.00	0.00	0.00	82	63
5-Nov-06	Off	87.25		0.00	0	0.00	0.00	0.0	0.0	82	63
6-Nov-06	Off	87.25		0.00	0	0.00	0.00	0.0	0.0	82	63
7-Nov-06	On	93.25	14	176.27	253,829	3826.25	2763.33	60.12	43.42	97	74
8-Nov-06	On	99.25	15	170.47	245,477	5523.64	4835.83	83.94	73.49	118	92
9-Nov-06	On	105.25	16	124.74	179,626	4800.21	4352.25	53.38	48.40	131	104
10-Nov-06	Off	105.25		0.00	0	0.00	0.00	0.0	0.0	131	104
11-Nov-06	Off	105.25		0.00	0	0.00	0.00	0.0	0.0	131	104
12-Nov-06	Off	105.25		0.00	0	0.00	0.00	0.0	0.0	131	104
13-Nov-06	Off	105.25		0.00	0	0.00	0.00	0.0	0.0	131	104
14-Nov-06	**On**	**119.92**		**168.48**	**242,611**	3386.99	2901.50	**50.87**	**43.58**	**162**	**131**
15-Nov-06	On	133.58	17	173.31	249,566	3386.99	2901.50	52.33	44.83	192	157
16-Nov-06	Off	133.58		0.00	0	0.00	0.00	0.0	0.0	192	157
17-Nov-06	On	148.58	18	180.33	259,675	3150.23	2694.25	50.64	43.31	223	184
18-Nov-06	On	172.58		180.33	259,675	2912.21	2495.29	47.31	40.54	271	224
19-Nov-06	On	196.58		180.33	259,675	2674.20	2296.33	45.44	39.03	316	263
20-Nov-06	**On**	**220.58**		**197.29**	**284,098**	2436.18	2097.37	**42.85**	**36.89**	**359**	**300**
21-Nov-06	On	244.58		197.29	284,098	2198.16	1898.41	38.07	32.88	397	333
22-Nov-06	On	256.92	19	192.46	277,142	2075.85	1796.17	35.62	30.82	415	349
23-Nov-06	Off	256.92		0.00	0	0.00	0.00	0.0	0.0	415	349
24-Nov-06	Off	256.92		0.00	0	0.00	0.00	0.0	0.0	415	349
25-Nov-06	Off	256.92		0.00	0	0.00	0.00	0.0	0.0	415	349
26-Nov-06	Off	256.92		0.00	0	0.00	0.00	0.0	0.0	415	349
27-Nov-06	Off	256.92		0.00	0	0.00	0.00	0.0	0.0	415	349
28-Nov-06	Off	256.92		0.00	0	0.00	0.00	0.00	0.00	415	349
29-Nov-06	On	264.50	20	194.08	279,475	0.00	0.00	0.00	0.00	415	349
30-Nov-06	On	288.50		194.08	279,475	0.00	0.00	0.00	0.00	415	349
1-Dec-06	On	297.50		194.08	279,475	0.00	0.00	0.00	0.00	415	349
2-Dec-06	Off	297.50		0.00	0	0.00	0.00	0.00	0.00	415	349
3-Dec-06	Off	297.50		0.00	0	0.00	0.00	0.00	0.00	415	349
4-Dec-06	On	312.50		190.86	274,838	0.00	0.00	0.00	0.00	415	349
5-Dec-06	On	336.50		190.86	274,838	0.00	0.00	0.00	0.00	415	349
6-Dec-06	On	360.50		190.86	274,838	0.00	0.00	0.00	0.00	415	349
7-Dec-06	On	369.50		190.86	274,838	0.00	0.00	0.00	0.00	415	349
8-Dec-06	Off	369.50		0.00	0	0.00	0.00	0.00	0.00	415	349
9-Dec-06	Off	369.50		0.00	0	0.00	0.00	0.00	0.00	415	349
10-Dec-06	Off	369.50		0.00	0	0.00	0.00	0.00	0.00	415	349
11-Dec-06	On	382.50		196.58	283,075	0.00	0.00	0.00	0.00	415	349
12-Dec-06	On	406.50		196.58	283,075	0.00	0.00	0.00	0.00	415	349
13-Dec-06	On	415.50		196.58	283,075	0.00	0.00	0.00	0.00	415	349
Operation Summary:				**209.9 (avg.)**	**7,254,878 (total)**	**3,062.1 (avg.)**	**2468 (avg.)**	**35.4 (avg.)**	**29.2 (avg.)**	**415 (total)**	**349 (total)**